Selectively Plated Trivalent Chrome

Presented by
Chris Mance, Tinker AFB

Report Documentation Page

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Background

- Developed 10 years ago by Dr. Zoltan Mathe at Liquid Development Corporation (LDC).
- Process is fully developed, but main customer interest has been for smaller, limited applications such as touch-up of existing chrome.
- Referred to as LDC-HTC^3

Properties of LDC-HTC^3

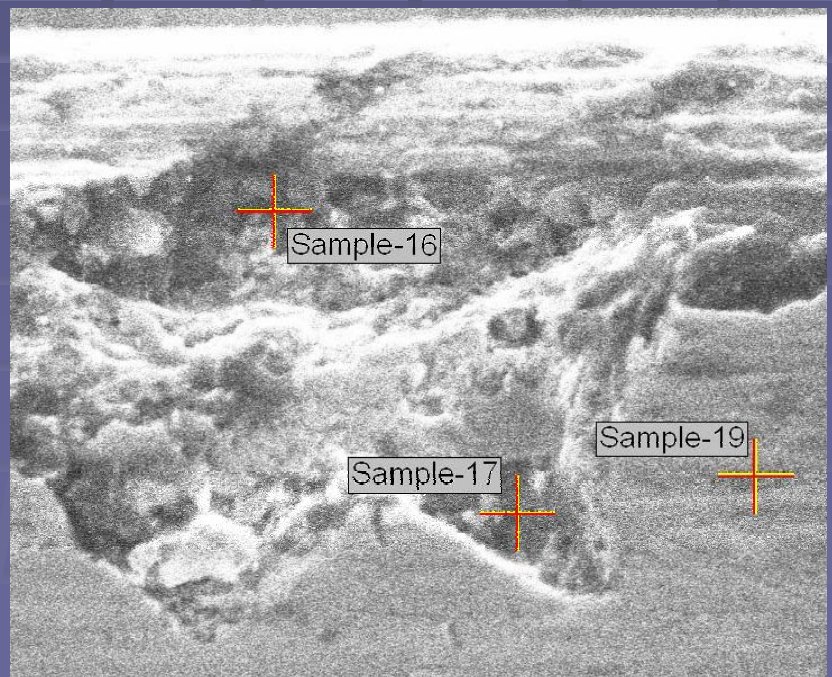
- Hardness (HV) 900-1200
  - As good or better than Electrolytic Hard Chrome (EHC)
- Taber Wear Index of 0.7 mg/1000 cycles
  - 3 times better than EHC
- Coefficient of friction equal to EHC
- Can build deposits 3 times faster than EHC
- Application of a nickel flash prior to LDC-HTC^3 eliminates need for post bake. No hydrogen embrittlement.
- Line of sight NOT required

Repair of Existing Chrome

- LDC-HTC^3 can build new chrome on existing chrome.
- No need to strip existing chrome if remaining coating is acceptable.

Coating Thickness

- Can plate to thicknesses in excess of 10-mils.
  - Cause of pitting seen at thicker coatings isolated and identified at Tinker AFB.

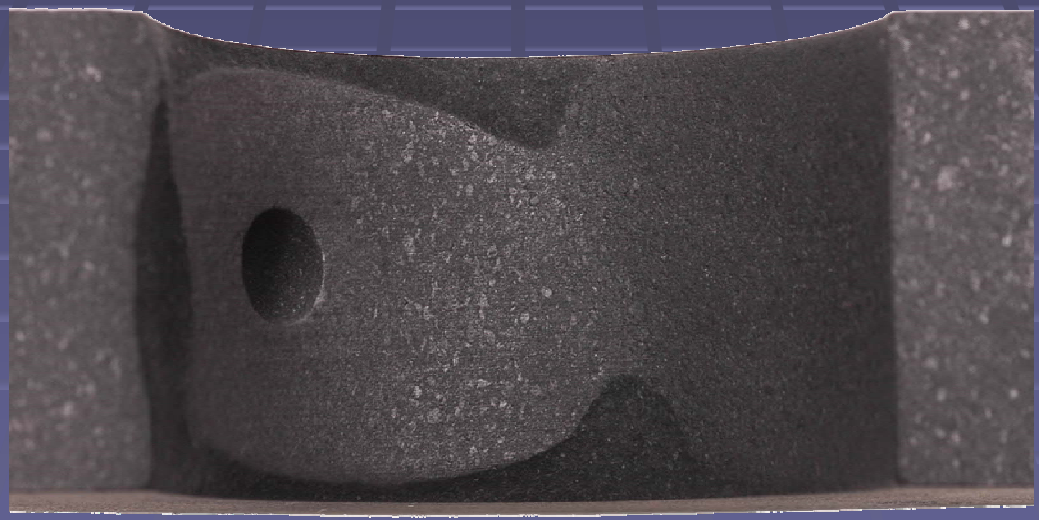


Sample-19
0.0% Carbon

Sample-16
48.7% Carbon

Sample-17
62.5% Carbon

- Carbon contamination caused by corrosion of graphite anode used in the process.



- Replacement of graphite anode with platinum niobium mesh eliminates graphite contamination.

Coating Thickness

- Coating thickness can very accurately be predicted by measuring amp-hrs during the process.
  - Thickness predictions +/- 0.00001 inches possible with selective plating.

- “Plate To Tolerance”

Coating Finish

- Surface finishes as good as 10 Ra have been measured at Tinker.
  - Surface finishes better than 16 Ra generally called for after grinding and polishing.

- “Plate To Finish”

Post Machining

- “Plate to Tolerance, Plate to Finish”
- Post grinding and polishing may be completely eliminated

Micro/Macro Cracking of Coating

- To date, no micro or macro cracking has been observed in LDC-HTC^3 coated samples
  - EHC has large tensile stresses associated with it, resulting in microcracking “spider webs”.

- The lack of cracking in LDC-HTC^3 could mean:
  - Large residual stresses could remain in the coating and are not being relieved by microcracking as in EHC.
    - Coating does not crack during cutting and grinding of metallurgical samples.
  - Residual stresses in LDC-HTC^3 could be less than those in EHC.
    - Selectively plated coatings in general are less porous and more dense when compared to tank plated coatings.
- Lack of cracking could mean a dramatic improvement in corrosion resistance of LDC-HTC^3 as compared to EHC.

Environmental/Safety Hazards

- LDC-HTC^3 is
  - Non-oxidizing
  - Non-toxic
  - Non-carcinogenic
  - Non-corrosive
  - pH of 7.0
- Process is carried out in a “closed system”.
  - 6 gallons of solution contained in a closed heater/pump system.
  - Solution is passed through anode over part and returned to heater/pump.
  - No chrome rinse water is generated.
  - Solutions used to prepare parts (~65 mL per part) are segregated and collected.
  - A finding of “CATEX” is anticipated at Tinker
    - “No significant individual or cumulative effect on the human environment”

Lean Cell Applicable

- LDC-HTC^3 is ideally suited to the Lean Cell concept.
  - Equipment is low cost
    - Less than $30,000 per station.
  - Small footprint needed
    - Equipment fits on a workbench
  - Very little masking of part is required
    - Taping of boundaries using plating tape
  - Cleaning and preparatory steps carried out using selective plating equipment
  - Parts can be completely processed in as little as 4 hours
    - Ready to be reinstalled

Cost Comparison for Trivalent Brush Plated Chrome vs. Electrolytic Chrome Technologies

	Trivalent Brush Plated Chrome		Hexavalent Chrome Plating
Capital and Installation (Per Trichrome Lean Cell)	$30,000		N/A
Operational Costs:			
Consumables Cost (25 square inch area, 1500 parts annually)	$121,247		$109,875
Gas	$0		$0
Labor (Including "Shipping & Handling" and Post-Plate Machining and Polishing for HVOF and Hexchrome)	$29,580		$318,750
Rinsewater treatment	$0		$500
Disposal	$0		$1,000
Annual Total (w/o capital)	$150,827		$430,125
Economic Analysis Summary:			
Annual Savings for Trivalent Brush Plated Chrome:			**$279,298**
Capital Cost for Diversion Equipment/Process:			$30,000
Payback Period for Investment in Equipment/Process:	Years		0.11
	Months		1.29

Current Status

- Submission of project to ESTCP complete.
  - Submitted with contributors from
    - Tinker Air Force Base
    - Oklahoma City ALC
    - Army Research Labs
    - Naval Research Labs
    - NAVAIR
    - Naval Air Systems
    - PEWG
    - HCAT
    - Boeing
    - Pratt & Whitney
- Supplementary funding obtained at Tinker AFB
  - Testing will continue during ESTCP review process.

Summary

- Metallurgical properties measured to date “as good or better” than EHC
- Process does not require line of sight
- Could eliminate stripping of existing chrome
- Could eliminate post grinding and polishing
- Environmental and health concerns greatly reduced or eliminated